DORIC

OWNER'S MANUAL

# SERIES 400

## DIGITAL TEMPERATURE TRENDICATORS

DORIC SCIENTIFIC
DIVISION OF EMERSON ELECTRIC CO.

PROPERTY OF: CALIBRATION

## WARRANTY

Doric Scientific hereby warrants each instrument of its manufacture as follows:

1. At the time of delivery of each instrument to the original purchaser, Doric Scientific UNCONDITIONALLY WARRANTS that it shall be free from defects in parts, materials and workmanship; and

2. Commencing with the date of shipment of each instrument to the original purchaser, Doric Scientific UNCONDITIONALLY WARRANTS that each unit shall remain free from defect in parts, materials and workmanship for a period of 1 year. Longer periods are available at extra cost.

In the event any instrument fails to meet the terms of this warranty, Doric Scientific agrees to provide corrective action. Refer to the Owner's manual for the proper procedure.

The warranties herein shall not obligate Doric Scientific in any manner whatsoever with respect to, and shall not be applicable to, any defects which after an inspection by Doric Scientific are not to Doric Scientific's reasonable satisfaction demonstrably the result of defective parts, materials or workmanship. We are not liable for consequential damages.

## CERTIFICATION

Doric Scientific certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when shipped from the factory. Doric Scientific further certifies that its calibration measurements are traceable to NBS.

**DORIC SCIENTIFIC**
**DIVISION OF EMERSON ELECTRIC CO.**
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Manual 400-4200-02 Printed in U. S. A. Doric Scientific 6-75

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STABRO LABORATORIES, INC.
TECHNICAL REFERENCE LIBRARY
DOCUMENT CONTROL ADMINISTRATOR

# SECTION 1

# DESCRIPTION

## 1.1 GENERAL DESCRIPTION

This manual contains complete installation, operation and service information for Doric Scientific's Series 400 digital temperature Trendicators. The instruments are solid-state, temperature measuring indicators which digitally display the magnitude of a wide range of thermocouple inputs in degrees of Celsius or Fahrenheit. The instruments feature a microvolt level analog-to-digital converter (PMOS LSI chip), digital linearization, dual-slope integration and L.E.D. displays. Either grounded or floating thermocouples may be used.

The displays are the in-line, planar, L.E.D. type, whose 0.63 inch high red numerals are easily read through the front plexiglas panel. A single "–" display at the left of the readout indicates a negative polarity. No symbol is displayed for positive readings. All dashes (–––) across the display indicates an overload or open thermocouple condition.

The instruments provide resolution of 1°F or 1°C in the standard TC system with 0.1°F or 0.1°C available where higher sensitivity is required. All models are easily convertible between Celsius and Fahrenheit by a programming module adjustment on the main circuit board. Kits are available to change the thermocouple range in the field.

The units operate from a 115 or 230 (+10%, -15%) VAC power source, 50 or 60 Hz. Power consumption is about 1.5 watts.

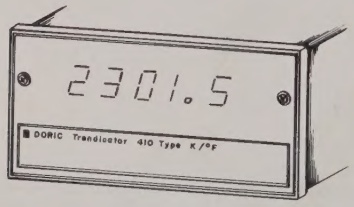
Each unit is delivered with panel mounting hardware as standard equipment. Rack and bench top mounting hardware are optionally available to accommodate those modes of installation.

Several models of the Series 400 instruments are covered in this manual. The text refers to all models unless a particular model is specified.

## 1.2 DESCRIPTION OF THE MODELS

### 1.2.1 MODEL 400/410

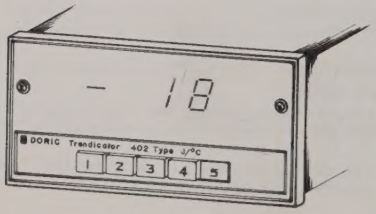
The Model 400 is a single range (choice of J, K, T, R, S, or B) thermocouple type instrument. The range and Celsius or Fahrenheit are pre-selected and programmed at the factory; however, field changeable range kits are available to convert to any of the other 5 types. The Model 400 may be used in conjunction with one or more Model 405 selectors when 10 points or more of measurement in the same range are required. The Model 410 is the same as the 400 except it provides 0.1° resolution and the readout is a 5-digit display, including a decimal point.




*MODEL 410*
*TYPE K*
*0.1°F RESOLUTION*
*POSITIVE POLARITY DISPLAY*

### 1.2.2 MODEL 402/412

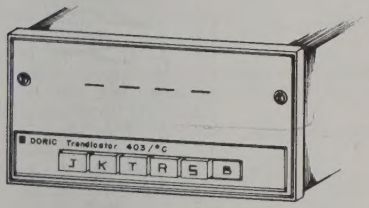
The Model 402 is a single range (choice of J, K, T, R, S, or B) five point thermocouple indicator. The range and Celsius or Fahrenheit are pre-selected and programmed at the factory, but may be changed in the field with an optional kit. The unit contains 5 interlocking pushbuttons on the front panel, permitting the selection of any 1 of the 5 points within the single range. The Model 412 is the same as the 402 except it provides 0.1° resolution, and the readout has a 5-digit display, including a decimal point.




*MODEL 402*
*TYPE J*
*1.0°C RESOLUTION*
*NEGATIVE POLARITY DISPLAY*

### 1.2.3 MODEL 403/415

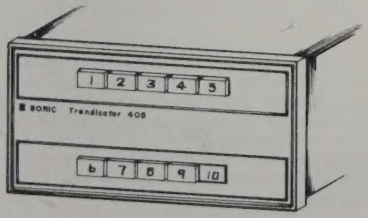
The Model 403 is a multi-range thermocouple type instrument, permitting the selection of any range (J, K, T, R, S, and B) by simply pressing a pushbutton on the front panel. The 6 ranges coupled with a choice of °F or °C provide a combination of 12 range selections. Conversion from Celsius to Fahrenheit (and vice versa) is made by an adjustment of an interior slide switch. The Model 415 is the same as the 403 except it provides 0.1° resolution, and the readout is a 5-digit display, including a decimal point.




*MODEL 403*
*1.0°C RESOLUTION*
*OVERLOAD OR OPEN*
*TC DISPLAY*

### 1.2.4 MODEL 405

The Model 405 is a 10-point pushbutton selector designed to add multi-point capability to single (Model 400/410) range indicators. The unit is the same size as the indicator models and may be mounted side-by-side in the same rack with other indicators or selectors. The front panel contains 2 rows of 5 pushbuttons, numbered 1 through 10 inclusive. Each row of 5 buttons is mechanically interlocked. To prevent erroneous display due to selection of 2 buttons, Option 001 provides display blanking (- - - -) for one or multiple selector units.

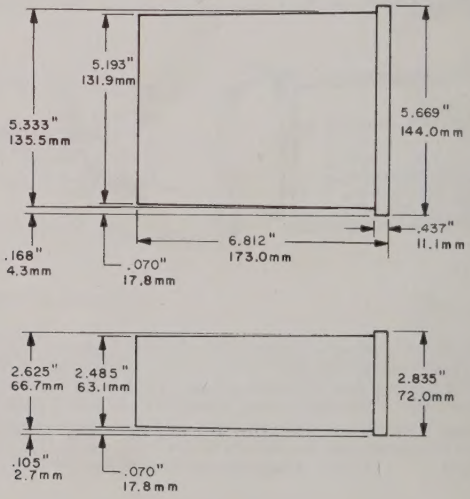



*MODEL 405*
*MULTI-POINT*
*SELECTOR*

## 1.3 PHYSICAL DESCRIPTION

All Series 400 instrument cases are constructed of die cast aluminum, designed specifically for flush panel mounting. A flanged front around the outer perimeter allows the unit to slide into a rough-cut panel cutout and conceal the rough edges. Bench and rack mounting hardware are also available.

The dimensions of the case are shown in the following outline drawing. The unit weighs approximately 2.5 pounds.




## 1.4 WARRANTY REPAIR

In the event the instrument fails during the warranty period, contact Doric Scientific's Customer Service Department (714-565-4415) immediately. Unauthorized repair may void the warranty. Depending on the nature of the problem, Customer Service will advise the procedure for corrective action. If directed to return the instrument for repair, refer to packing instructions in Paragraph 2.2.

Instruments covered by Doric's Service Contracts are handled in accordance with the terms and conditions specified in the contract. Inquiries should be directed to Doric's Customer Service Department.

## 1.5 SPECIFICATIONS

Input Circuit:
Floating potentiometric operational amplifier, allowing grounded or floating thermocouple.
Measurement Method:
Auto-Zero, dual slope.
Overload:
±120 VAC or DC continuous. 230 VAC or DC intermittently will not cause damage.
Maximum Source Resistance:
250 ohm
Linearization:
100% digital with no analog approximation circuits, non-linear slidewires or other electromechanical/optical methods.
Common Mode Rejection:
120 db at 59 Hz with 100 ohm unbalance, 250 VAC or 500 VDC maximum.
Normal Mode Rejection:
60 db at 59 Hz, increasing at 18 db per octave.
Calibration Drift:
Maximum ±1° per year for base metals.
Circuitry:
Custom LSI analog-to-digital converter chip and advanced low-level analog technology combined with bright 0.63 inch solid state planar display.
Calibration:
Two points, zero and span, adjustable from the front panel. No linearization adjustment ever required.
Resolution and Repeatability:
1° F or 1°C (Models 400, 402 and 403)
.1° F or .1°C (Models 410, 412, and 415)
Ambient Temperature Stability:
Cold Junction:
0.025 degree/degree for base metals.
0.05 degree/degree for noble metals.
Zero:
1μV/°C for 1° model
0.5μV/°C for 0.1° model
Span:
0.01% of reading per °C for 1° model
0.005% of reading per °C for 0.1° model
Thermocouple Burnout Detection:
-30 nanoamp DC break detect causes an all dash (- - - -) display.

Display

Highly reliable L.E.D. display provides superior brightness with lower power consumption, pre-aged for long life.

Measurement Speed:

From 3 readings per second at low magnitudes to 0.7 readings per second at magnitudes of 3000°F. Speed is the same on 1° and 0.1° models, °C or °F.

Input Step Function Settling Time:

Approximately 3 seconds for full scale step.

Power:

4 watts maximum. Choice of:

100–125 VAC, 48–62 Hz
190–250 VAC, 48-62 Hz
85–110 VAC, 48–62 Hz (optional)

Operating Temperature:

0 to 50°C; 32 to 122°F

Size:

Approximately 5.3 inches wide, 2.8 inches high and 6.8 inches in depth. See paragraph 1.3. Metric dimensions are DIN standard.

Weight:

Approximately 2.5 pounds

Accuracy By TC Temperature Ranges:
(Does not include thermocouple errors)

| TC TYPE MATERIAL | RANGE | MAX. LINEARIZATION ERROR (all ±) | ACCURACY (all ±) | |
|---|---|---|---|---|
| | | | 400/402/403 | 410/412/415 |
| J<br>Iron-Constantan | -328°F to +1712°F<br>-200°C to +933°C | <0° = 0.18° >0° = 0.22°<br><0° = 0.1° >0° = 0.12° | 1°<br>1° | 0.6°F<br>0.5°C |
| K<br>Chromel-Alumel | -208°F to +2552°F<br>-133°C to +1400°C | <0° = 0.7° >0° = 0.18°<br><0° = 0.39° >0° = 0.1° | <0° = 1.5° >0° = 1°<br>1° | <0° = 1.2° >0° = 0.8°<br><0° = 0.8° >0° = 0.5° |
| T<br>Copper-Constantan | -328°F to +752°F<br>-200°C to +400°C | <0° = 0.12° >0° = 0.1°<br><0° = 0.07° >0° = 0.06° | 1°<br>1° | 0.5°F<br>0.5°C |
| R<br>Platinum-Platinum 13% Rhodium | +32°F to +3252°F<br>0°C to +1788°C | <350° = 1° >350° = 0.22°<br><200° = 0.6° >200° = 0.12° | <350° = 3° >350° = 2°<br>2° | <350° = 3° >350° = 1.5°<br>0.5°C from 800°C to 1300°C<br><200° = 2°, >200° = 1° |
| S<br>Platinum-Platinum 10% Rhodium | +32°F to +3252°F<br>0°C to +1788°C | <600° = 1.0° >800° = 0.23°<br><315° = 0.6° >315° = 0.13° | <600° = 3° >800° = 2°<br>2° | <600° = 3° >600° = 1.5°<br>0.5°C from 800°C to 1300°C<br><315° = 2°, >315° = 1° |
| B<br>Plat. 30% Rhod./ Plat. 6% Rhod. | 912°F to +3392°F<br>489°C to +1866°C | 0.5°<br>0.27° | 4°<br>2.5° | 2.5°<br>1° |

J, K and T are base metals; R, S and B are noble metals.

## SERIES 400 ORDERING GUIDE

| ITEM DESCRIPTION (All models panel mounted, unless otherwise noted) | MODEL/OPTION NUMBER |
|---|---|
| Single TC type (choice of any of 6); internal °F/°C selector; field changeable range to any other type (of the 6 types); 1.0° resolution and repeatability | 400-X*-Y* |
| Same as above, but with 5-point interlocking pushbutton selector mounted in same case below display | 402-X*-Y* |
| Same as Model 400, but with 0.1° resolution | 410-X*-Y* |
| Same as Model 402, but with 0.1° resolution | 412-X*-Y* |
| 10-point, pushbutton selector in separate case (same size as indicator), with 2 rows of 5 switches. Mechanical interlocking within each row of 5. To prevent erroneous display due to selection of 2 buttons (e.g. one in each row) option 001 "Switching Error Indication" is highly recommended. (Not used in conjunction with Model 402 or 412.) | 405 |
| Switching Error Indicator Option: Plug-in PC-board for either Model 400 or 410 only. Causes display blanking (----) in event that more than one button is pushed on a 405. Works for one or multiple 405's. | 001 |
| 12 ranges, pushbutton selection (J, K, T, R, S, & B); °F/°C selector; 1.0° resolution and repeatability | 403-Y* |
| Same as above, but with 0.1° resolution | 415-Y* |
| Field range-change-kit. Change any single TC Trendicator (400, 402, 410 or 412) to any other (of the 6) TC types; °F/°C conversion included. | K-400-X* |
| Field range-change-kit for six TC types | K-400-6 |
| Spare PMOS LSI Chip for 1.0° Trendicators | K-400-CHIP |
| Spare PMOS LSI Chip for 0.1° Trendicators | K-410-CHIP |
| Spare parts kit without PMOS LSI Chip | KS |
| First year warranty free; each subsequent year optional when purchased with initial order; specify (#) years | BW ( ) |
| Lab Mount case accessories (feet and stand) | W5 |
| Rackmount Adapter, for 1, 2, or 3 units; specify (#) | W6 ( ) |
| Extra Manuals (one free with unit) | H ( ) |

X* = Specify TC type (J, K, T, R, S, or B)
Y* = Specify unit to be delivered indicating °F or °C

# SECTION 2

# INSTALLATION

## 2.1 UNPACKING AND INSPECTION

Although the Series 400 are rugged instruments, care must be exercised to properly pack the units to preclude shipping damage. When shipped from the factory a custom-molded foam shipping container is used to cushion shock and vibration normally encountered in transit.

When the instrument is received, examine the shipping container for evidence of damage. If none is found, unpack the instrument carefully, watching for signs of damage. If evidence of damage is apparent, stop unpacking immediately and request the carrier prepare a Damage Inspection Report. Forward this report to Doric and await handling instructions.

If the instrument shows no sign of damage, the unit may be subjected to the functional test described in paragraph 2.4 to ensure the instrument is operating properly.

## 2.2 REPACKING, RETURNING THE INSTRUMENT

If convenient, the original shipping container should be retained to return the instrument for repair or modification. Documentation accompanying the instrument should include the instrument model number, serial number, your name, address, telephone number and extension, and identification of the problem or rework instructions. This will assist Doric's Customer Service Department in expediting the job.

To aid in repacking the instrument in the event the original shipping container has been discarded, the following suggestions are offered:

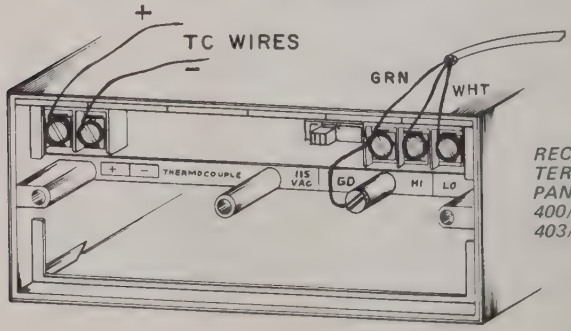
a. Select a strong cardboard box of sufficient size to allow an inch of packing material around all sides of the unit.
b. Ensure the printed circuit boards are secured and the front and rear panels are firmly in place.
c. Wrap the instrument in plastic or strong paper. Place it centrally in the shipping container, and pack polyfoam, bubble pack, or rubberized hair around all 6 sides of the instrument.
d. Secure the flaps of the carton with strong tape and be sure to label the shipping container: "FRAGILE, DELICATE INSTRUMENT." Send to Doric Scientific, freight prepaid. Never use U. S. mail or parcel post.

## 2.3 INSTRUMENT HOOKUP

All connections to the Series 400 indicators are made in the rear of the instruments. To gain access to the recessed termination panel, the back plate must be removed.

The 6-foot power cord, supplied with each instrument, is wired to the rear power terminals marked: GND, HI, LO. Each wire end of the power cord is color-coded. The green wire is connected to GND, the black to HI, and the white wire to the terminal marked LO. Wire ends are placed behind the plate of the terminal and the screw tightened to clamp the wire.

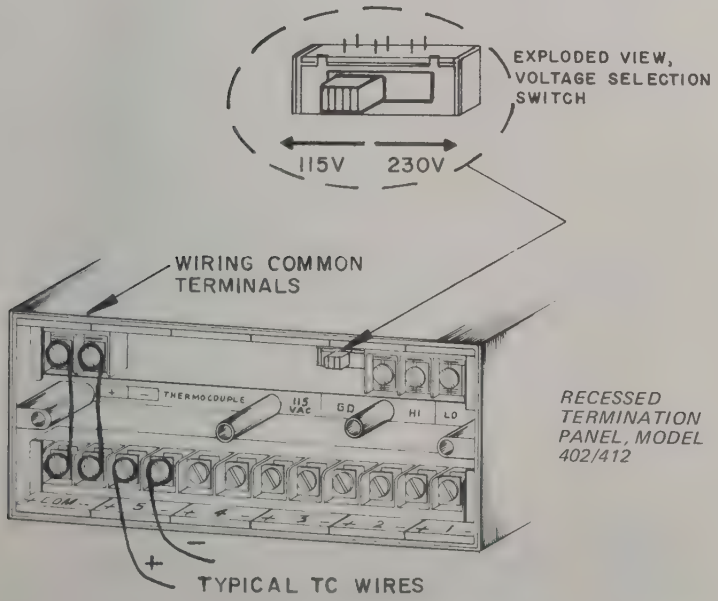
A slide switch on the recessed termination panel selects 115 or 230 VAC operation. Be sure this switch is in the proper position before connecting to a power source.




*RECESSED TERMINATION PANEL, MODELS 400/410 AND 403/415*

In the Models 400/410 and 403/415, thermocouple lead-in wires are connected to the instrument at the terminals in the upper left corner of the rear recessed area. The terminals are marked + and –. Each TC wire is placed behind the plate of the respective terminal and the screw tightened to clamp the wire.

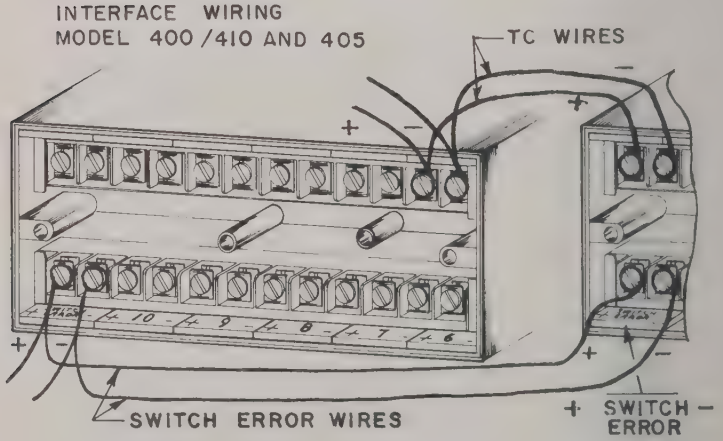
* In the Model 402/412 the thermocouple lead-in wires are connected to the + and – terminals labeled 1 through 5. The numbers correspond to the numbers on the front panel pushbuttons. Terminals marked "COM" must be connected to the terminals immediately above with TC wire of the same type as the instrument range module (+ terminal to + terminal and – terminal to – terminal).




*RECESSED TERMINATION PANEL, MODEL 402/412*

When the Model 405 is used in combination with Model 400/410, thermocouple lead-in wires are connected to the 10 terminal sets on the rear panel of the Model 405. Thermocouple wire interfacing between the two models is shown in the following sketch. + terminals are always connected to + terminals, and – terminals to – terminals.

The power cord and TC lead-in wires exit the recessed area through the slots on the sides of the rear cover. (see sketch, page 2-5)




*RECESSED TERMINATION PANEL, MODEL 405*

*MODEL 400/410 WITH OPTION 001*

## 2.4 CHECKOUT PROCEDURE

When the instrument is first received or when a basic functional checkout is desired, the unit may be tested as follows:

a. Remove the rear panel of the instrument.
b. With a piece of copper wire, short all signal input terminals together.
c. Connect the instrument to an appropriate power source.
d. Examine the display. The digital readout should show the approximate room temperature in °C or °F as applicable.

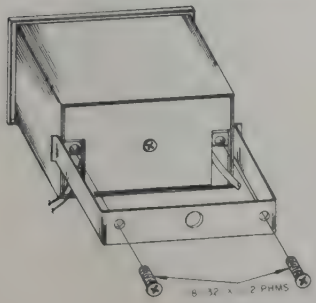
NOTE: Thermocouple Type B is an exception to the above procedure. For this type, a precision millivolt calibrator may be used to simulate TC input. The display should verify the source input. For example, a 4.833 millivolt input should read approximately 1832°F (1000°C).

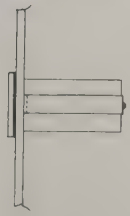
## 2.5 MOUNTING THE INSTRUMENT

Three methods of mounting the Series 400 instruments are available.

### 2.5.1 PANEL MOUNTING

For panel mounted operations, a U-shaped bracket is supplied with each instrument. The U-channel mounts from the back of the instrument over the rear plate and tightens against the back side of the panel. The flange around the case's front perimeter interfaces with the panel's front surface. As the channel screws are tightened, the panel is gripped between the flange and the channel. Panel cutout dimensions are 5.43 inches (138,0 +1, –0 mm) by 2.67 inches (68,0 +0, –7 mm).

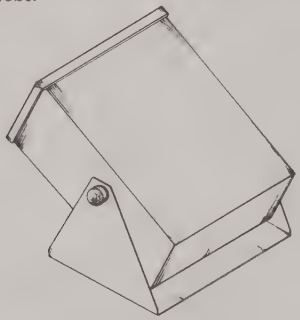


*PANEL MOUNTING HARDWARE*

### 2.5.2 BENCH MOUNTING (OPTION W5)

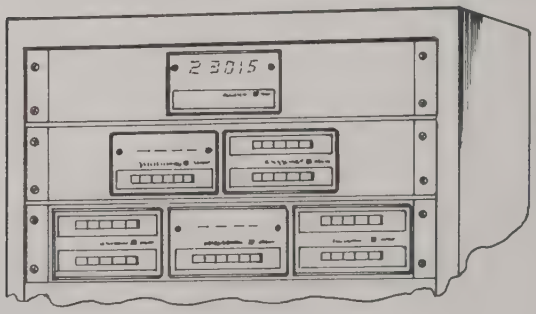
For bench top applications, option W5 provides a mounting bracket with 4 rubberized feet. The instrument pivots to any viewing angle by adjusting the bracket turn knobs.



*BENCH MOUNTING HARDWARE*

### 2.5.3 RACK MOUNTING (OPTION W6)

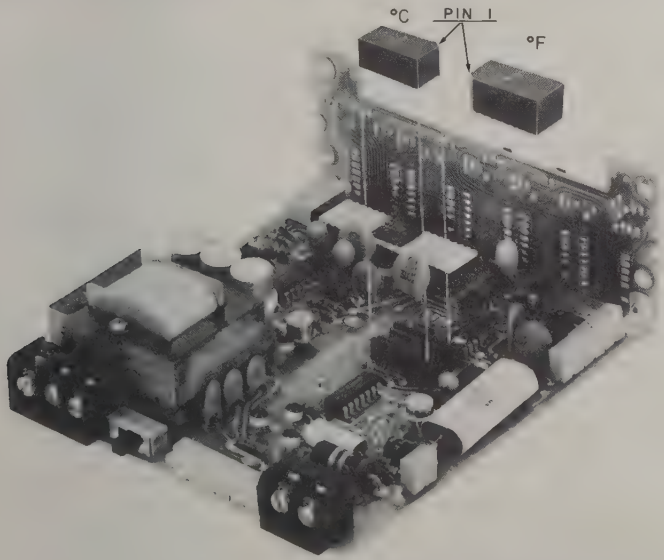
For rack-mounted operations, an adapter plate with 1, 2, or 3 cutouts is available. The plate is 3.5 by 19 inches. The instrument is inserted into the cutout from the front until the case's front flange contacts the adapter. The U-channel, supplied with the instrument, is mounted from the rear of the instrument as described in Paragraph 2.5.1. The rack adapter is then mounted into the rack and TC wires and power cord attached as discussed in Paragraph 2.3.




*INSTRUMENTS INSTALLED IN RACK ADAPTERS WITH 1, 2, OR 3 CUTOUTS*

## 2.6 CHANGING TRENDICATOR FROM °F to °C, °C to °F

Each single TC instrument (Models 400, 402, 410, and 412) shipped from the factory is programmed for °C or °F readout as specified on the order. The user, however, may readily convert from °C to °F or from °F to °C by a 180 degree rotation of the programming module. Each module is identified with the TC type (J, K, T, R, S or B) on its top surface. The beveled edge on one corner of this module identifies Pin 1. As shown in the below illustration, when Pin 1 is nearest the front of the instrument, the readout is in °C. To change to °F, lift the module from its socket and rotate 180 degrees until Pin 1 is away from the front of the instrument, pointing toward the transformer. Plug the pins back into the socket in this position and the readout displays °F. Reverse the procedure when converting from °F to °C.




*CHANGING PROGRAMMING MODULE FROM °F to °C, °C to °F*

Since each instrument is capable of °F or °C readout, two nameplates are supplied with each instrument, one for each unit of measurement. It is recommended that as the module is changed, the nameplate also be changed to reflect the correct unit of readout. The plate is removed by gently prying it from the plexiglass front panel. The replacement plate is installed in the same position on the panel (after the protective strip is removed from the adhesive). Spare plates are available from Doric Scientific.

In the multifunction units (Models 403 and 415), the unit of measurement is changed by a slide switch (S7) on the multifunction board (Assembly 400-4150). When the switch is closest to the front of the instrument, the readout is in °C. The rear position is °F.

## 2.7 CHANGING THERMOCOUPLE TYPE

In the single TC instruments (Models 400, 402, 410, and 412), an individual programming module is used for each of the six thermocouple types (J, K, T, R, S and B). To change the TC type simply remove the installed module and replace it with the module corresponding to the thermocouple type to be used (see table, page 1-6). Since the module may be installed to display °F or °C, review paragraph 2.6 before placing the module in the socket. The nameplate should also be changed to reflect the current TC type and unit of measurement.

In the multifunction units (Models 403 and 415), the TC type is changed by selecting the appropriate pushbutton on the front panel.

When changing thermocouple type, it is essential to use interconnecting TC wiring of the same type material as the programming module. For example, a type J module must use iron-constantan TC wiring material.

## 2.8 CHANGING SOURCE VOLTAGE

The Trendicator operates from either a 115 (+10%, -15%) VAC, 50 or 60 Hz power source or a 230 (+10%, -15%) VAC, 50 or 60 Hz source. A slide switch on the rear recessed termination panel selects the voltage. As shown in the sketch on page 2-3, the switch position nearest the power cord connection is 230 VAC. Sliding the switch to the left enables 115 VAC operation.

# SECTION 3

# THEORY OF OPERATION

## 3.1 INTRODUCTION

The Trendicator 400 thermocouple thermometer accepts thermocouple outputs in the form of low level DC voltages and converts them to digital degrees. Dual slope integration is used for low noise and Doric's auto-zero circuitry assures drift free performance.

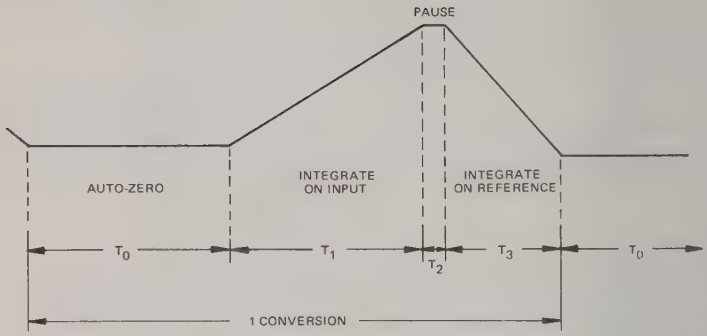
The Doric Trendicator utilizes the Large Scale Integration (LSI) PMOS semiconductor technology. All digital logic including thermocouple linearization tables is contained in one ion-implanted PMOS integrated circuit. A solid-state planar L.E.D. display is driven by on-chip decoders. Strobes provide a bright digital indication in degrees Fahrenheit or Celsius.

## 3.2 DUAL SLOPE A/D CONVERSION

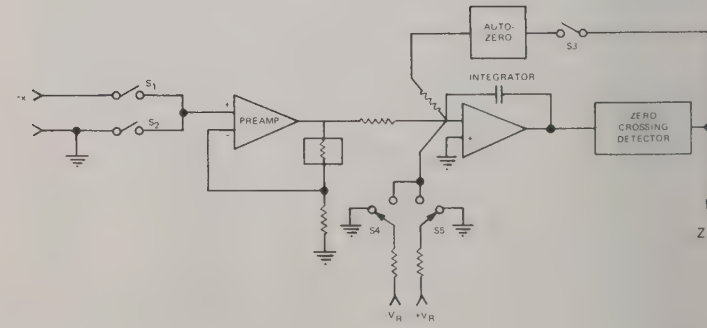
Refer to the schematic of analog circuits and diagram of dual slope technique on page 3-2. Before each conversion ($T_0$) $S_2$ and $S_3$ are closed. The auto-zero and zero cross detector circuits "close the loop" around the integrator, establishing a starting point for the integration.

During $T_1$, $S_1$ and $S_3$ are opened, $S_2$ is closed, and the integrator is allowed to ramp-up (down for + $E_{in}$). After a known number of clock pulses S2 is opened, S1 is closed, and a short pulse is instituted to settle capacitor charging.

During $T_3$, S5 is connected (S4 if + $E_{in}$) and the integrator ramps back towards zero at a constant rate. The amount of time (counts) required to return to zero is proportional to the input voltage. The system then returns to auto-zero again.




*DUAL SLOPE TECHNIQUE*




*ANALOG CIRCUITS SHOWING AUTO-ZERO*

## 3.3 CIRCUIT DESCRIPTION

### 3.3.1 POWER SUPPLY AND REGULATOR

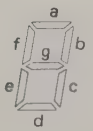
Refer to Schematic 400-6110 or 400-6120 in back of manual. AC power is connected at TB2, filtered for RFI, and connected to the power transformer, T1. The rectified secondary voltage provides +11 VDC on C15, -11 VDC on C16 and +11 VDC on C17 (L.E.D. display power). F.E.T. Q6 (source follower) drives Q7 (positive pass transistor). Q6 is driven by pin 7 of Z8 through R38. If excessive current (>100 mA) is drawn through R44, pin 1 of Z8 goes negative and drops the output voltage of Q6 and Q7. Q8 is the negative pass transistor whose base is driven by pin 8 of Z8 through R39. During overload, pin 14 of Z8 goes positive and reduces current through Q8 until the overload is removed.

Resistor R49 and potentiometer R50 adjust the power supply voltage. R50, the "span" adjust, adjusts the + and - reference voltages, symmetrically changing the + and - readings by the same percentage of reading.

### 3.3.2 DISPLAY AND DRIVER

The 7 segments (a thru g, see sketch below) of the common-cathode L.E.D. displays are driven by 7 emitter-follower Darlington transistors (Q9 thru Q15). These transistors drive through 7 resistors (R53 thru R59) to illuminate segments a thru g. The drive for digits "1" and "2" are or'd to provide the "g" segment for negative temperature displays. Transistors Q16 thru Q19 select the digit as driven through resistors R60 thru R63.

*DISPLAY SEGMENTS*




### 3.3.3 DIGITAL LOGIC

A9 is a PMOS digital integrated circuit operating from the regulated +7.2 and -7.2 voltages. Pins 16 thru 20 are digit strobes for driving digit-selection drivers. Pins 23 thru 29 provide segment data for generating the display. Pin 6 of Z9, a clock input, receives a 400 KHz clock generated by two inverters of Z7 and R51, R52 (Adjustment) and C21. Pin 33 is a power-on reset pin used in conjunction with R65 and C5. Pin 33 clears internal logic and prepares the dynamic logic for the first conversion. Pin 35 is the "start convert" line and delays conversion by a time constant generated by Q5, R29 and C8. Pins 37 thru 40 provide the A/D conversion switching logic (see schematic, page 3-2) for S5, S4, S3, and S1. The remainder of Z7 is used for inversion of S1, S4, and S5. Pins 5 thru 9 of Z9 are used in conjunction with assembly 400-4304-XX to configure the thermocouple type (J, K, T, R, S, B) and °F or °C operation.

### 3.3.4 ANALOG OPERATION

The thermocouple is connected to TB1. R1 generates a constant -6 nanoamps to force the input negative and cause an overload display when no TC is connected. Resistors R2, R5, R6 and capacitors C1, C2 and C3 make up the input filter.

The input to Z2 is alternately switched from the filtered thermocouple input to R9. Potentiometer R7 gives an adjustable low level offset through voltage dividers R8 and R10. R11 and R12 provide offset adjustment for low level amplifier Z2. R13 along with component carrier assembly provide a gain setting between 20 and 200 for Z2. C4 is a frequency compensating capacitor for Z2. R19, R26, R27 and R28 provide reference current for integrate on reference (IR) as switched by Z3. C7 compensates Z4. Z5 is the auto-zero preamplifier. R32 and R33 set the gain for Z5. C10 provides frequency compensation for Z5. R31, R30, C9 are compensation and hold components for auto-zero error correction. Pins 10 and 11 of Z1 provide the S3 switching function. R21 adjusts the DC level and R22 provides the bias for Q4, a source follower. R20 couples the error correction to the integrator summing node. R14, R16, R17, R64 and pins 9 to 8 of Z1 couple reference junction correction current from Q3 to the integrator. R3 and R4 provide bias current for Q3. Z6 and pins 5 to 6 of Z7 make up the zero crossing detector. C11 compensates Z6. R34 and R35 provide positive feedback (hysteresis) to prevent "chattering" of the zero comparator circuit.

# SECTION 4

# CALIBRATION

## 4.1 TEST EQUIPMENT

A DC calibrator capable of supplying voltages up to 100 mV with better than 1 microvolt resolution is required. A stable ice bath, accurate to 0.05° is also needed.

## 4.2 CALIBRATION PROCEDURE

a. Allow instrument to warm up for 30 minutes.

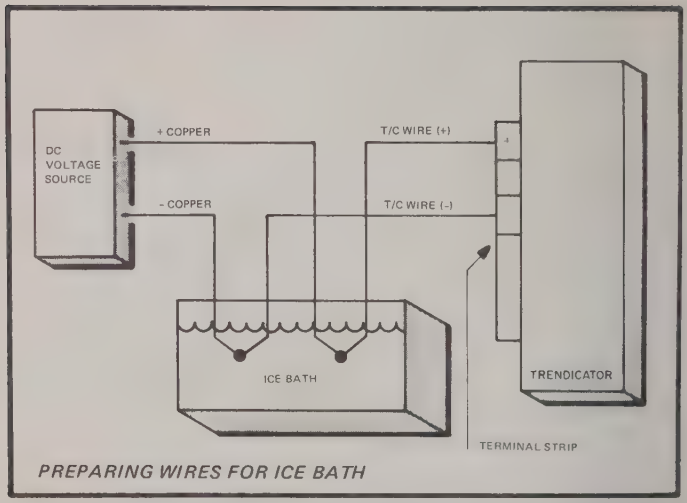
b. Connect the DC calibrator and ice bath to the Trendicator as shown in the calibration set-up diagram.

c. Prepare test wires for ice bath as shown in following sketch.

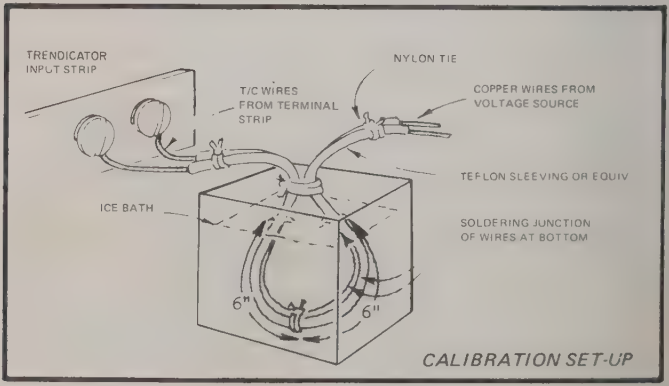
d. Refer to calibration chart and perform calibration.

EXAMPLE: For Type K, apply DC calibrator to + and – TC input strip on the Trendicator. Apply 0.000 mV and adjust the zero pot (R64) for a readout of 32°F or 0°C. Apply 54.845 mV to the TC input and adjust the + span pot (R50) for a readout of 2500°F. Looking down on the component side of the main board, R50 and R64 are to the right of the displays as shown on Assembly 400-4110.

NOTE: The "B" thermocouple type has little or no output at low temperatures. The Trendicator 400 series has accurate linearization above 912°F (488°C) but uses a single linear segment of 14.1 μV/°F (7.83 μV/°C) below this reading. The readout of the Trendicator below 912°F (488°C) will therefore represent 14.1 μV per degree F (7.83 μV/°C). The "B" thermocouple μV table can be used to approximate temperatures below 912°F (488°C).




*PREPARING WIRES FOR ICE BATH*




*CALIBRATION SET-UP*

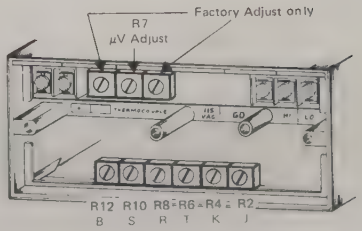
| T/C TYPE | MATERIAL | RANGE | INPUT (mV) | ADJUST | READ | INPUT | ADJUST | READ | INPUT | READ |
|---|---|---|---|---|---|---|---|---|---|---|
| J | Iron Constantan | 328 °F to +1712 °F<br>-200 °C to + 933 °C | 0<br>0 | Zero<br>Zero | 32 °F<br>0 °C | 39.407<br>42.283 | Span<br>Span | 1300 °F<br>750 °C | -7.519<br>-7.659 | -300 °F<br>-190 °C |
| K | Chromel Alumel | -208 °F to +2552 °F<br>-133 °C to +1400 °C | 0<br>0 | Zero<br>Zero | 32 °F<br>0 °C | 54.845<br>52.398 | Span<br>Span | 2500 °F<br>1300 °C | -4.381<br>-3.553 | -200 °F<br>-100 °C |
| T | Copper Constantan | -328 °F to + 752 °F<br>-200 °C to + 400 °C | 0<br>0 | Zero<br>Zero | 32 °F<br>0 °C | 20.801<br>20.869 | Span<br>Span | 750 °F<br>400 °C | -5.341<br>-5.439 | -300 °F<br>-190 °C |
| R | Platinum –<br>Platinum 13%<br>Rhodium | 32 °F to +3252 °F<br>0 °C to +1788 °C | 0<br>0 | Zero<br>Zero | 32 °F*<br>0 °C* | 19.518<br>20.878 | Span<br>Span | 3000 °F<br>1750 °C | –<br>– | –<br>– |
| S | Platinum –<br>Platinum 10%<br>Rhodium | 32 °F to +3252 °F<br>0 °C to +1788 °C | 0<br>0 | Zero<br>Zero | 32 °F*<br>0 °C* | 17.347<br>18.504 | Span<br>Span | 3000 °F<br>1750 °C | –<br>– | –<br>– |
| B<br>(see note) | Platinum 30%<br>Rhodium<br>Platinum –<br>6% Rhodium | 32 °F to +3392 °F<br><br>0 °C to +1866 °C | 0<br><br>0 | µV Adjust<br>R7<br>µV Adjust<br>R7 | 32 °F*<br><br>0 °C* | 13.763<br><br>13.585 | Span<br><br>Span | 3300 °F<br><br>1800 °C | –<br><br>– | –<br><br>– |

*Setting readout to exactly 32° F or 0° C may be difficult due to low µvolt output of noble metal thermocouples.

## *CALIBRATION FOR SINGLE FUNCTION UNITS*

The following chart lists the calibration sequence to be used for multifunction instruments. Step 1 (μV Adjust, R7) is required only for TC type B. If B range is not used, make no adjustment. The front panel ice point zero should be adjusted only on the first thermocouple used in the sequence. Up to 5°F variation in ice point reading from type to type may occur due to thermocouple sensor deviations. Next, adjust the appropriate full scale pots on the multifunction board for each range used. Inputs and nominal calibration values are the same as shown in the chart on page 4-3.

| CALIBRATION SEQUENCE | TC TYPE | ICE POINT ADJUST | MULTIFUNCTION FULL SCALE ADJUST |
|---|---|---|---|
| 1 | B | μV Adjust, R7 | R12 |
| 2 | J | zero | R2 |
| 3 | K | zero | R4 |
| 4 | T | zero | R6 |
| 5 | R | zero | R8 |
| 6 | S | zero | R10 |




*CALIBRATION FOR MULTIFUNCTION UNITS*

# SECTION 5

# PARTS LIST

## 5.0 INTRODUCTION

This section contains the electronic parts list for the Series 400 instruments, subdivided by circuit board assemblies. The list, compiled in reference designator order, contains the part description, the quantity per assembly, Doric's part number, the manufacturer's name and part number, and Doric's recommended spares.

The first time a part appears in the parts list, the total quantity per assembly is shown. No quantity is shown for subsequent listings of the part. A number in the REC SPARES column indicates the number of recommended spares. Doric recommends stocking spare parts on the basis of 100% of the total quantity in the assembly for fuses (F), 20% for most diodes (CR), transistors (Q), IC'S (Z), L.E.D.'s, and other recommended spare items.

The manufacturer's part number has been omitted on those parts which are easily obtained by using the description. In some cases, the part is available from several manufacturers. When this occurs, only one manufacturer is listed for convenience.

When ordering parts from Doric, all correspondence should be addressed to the Customer Service Department. A minimum order of $25.00 will be accepted on all orders for parts.

A spare parts kit (Option KS), containing specially selected spare parts for each unit, is also available for those who do not wish to select their individual spares and quantities. The PMOS LSI chip is not part of the kit and must be ordered separately.

**MAIN BOARD, ASSEMBLY 400-4110**

| REF DES | DESCRIPTION | QTY | DORIC P/N | MFR | MFR'S P/N | REC SPARES |
|---|---|---|---|---|---|---|
| C1-C3 | 2.2 MFD 35V Tantalum | 3 | 916-200-04 | Sprague | 196D | |
| C4 | 100 PF Disc Cap 1000V | 2 | 901-011-01 | Sprague | 5GAT10 | |
| C5 | .02 MFD Disc Cap 500V | 5 | 900-082-02 | Sprague | 5GASS20 | |
| C6 | 2.0 MFD 100V Polycarbonate | 1 | 911-032-05 | IMB | BA2B205 | |
| C7 | 100 PF Disc Cap 1000V | | 901-011-01 | Sprague | 5GAT10 | |
| C8 | .02 MFD Disc Cap 500V | | 900-082-02 | Sprague | 5GASS20 | |
| C9 | .22 MFD 100V Polycarbonate | 1 | 911-032-24 | IMB | BA2B224 | |
| C10, C11 | 5 PF Duramica Cap | 2 | 915-030-50 | Sprague | DM15 | |
| C12-C14 | .005 MFD Disc Cap 1000V | 3 | 900-085-03 | Sprague | 5GAD50 | |
| C15-C17 | 390 MFD 15V Electrolytic | 3 | 910-390-15 | Sprague | 672D | |
| C18 | .01 MFD Disc Cap 500V | 1 | 900-021-04 | Sprague | 5GASS10 | |
| C19, C20 | 10 MFD 35V Tantalum | 2 | 916-010-35 | Sprague | 196D | |
| C21 | 220 PF Duramica Cap | 1 | 915-032-21 | Sprague | | |
| C23 | 6.8 MFD Tantalum | 1 | 916-680-04 | Sprague | | |
| C24,C25 | .02 MFD Disc Cap 500V | | 900-082-02 | Sprague | BA2B205 | |
| CR1-CR6 | Rectifier, 200V | 6 | 966-002-00 | Diodes, Inc. | SD-2 | 2 |
| CR7-CR12 | Diode, 1N914 | 5 | 961-091-40 | Teledyne | IN914 | |
| DS1-DS4 | .63 LED Display | 4 | 968-081-00 | Litronix | DL-750 | 1 |
| Q1, Q2 | FET, Low Leak | 5 | 100-722-02 | Teledyne | U1742C | 1 |
| Q3 | Transistor, 2N 3393 Graded | 1 | 220-720-01 | Doric | Special | 1 |
| Q4-Q6 | FET, Low Leak | | 100-722-02 | Teledyne | U1742C | |
| Q7 | Power Transistor | 1 | 964-040-00 | RCA | 40347 | 1 |
| Q8 | Power Transistor | 1 | 964-040-02 | RCA | 40406 | 1 |
| Q9-Q19 | Darlington Transistor, TO-92 | 11 | 964-040-03 | Motorola | MPSA13NPN | 3 |
| R1 | 100 MEG 1/4W 10% | 1 | 943-201-07 | Sprague | | |
| R2 | 10K 2W 5% | 1 | 942-501-03 | Sprague | | |
| R3 | 7.5K ohm 1% | 1 | 920-475-01 | IRC | RN60C | |
| R4 | 100K Pot | 4 | 960-011-18 | Bourns | 3386C-1-104 | 1 |
| R5, R6 | 10K 1/4W 5% | 3 | 942-201-03 | Allen Bradley | | |
| R7 | 100K Pot | | 960-011-18 | Bourns | 3386C-1-104 | |
| R8 | 4.7 MEG 1/4W 5% | 2 | 942-204-75 | Sprague | | |
| R9 | 30K 1/4W 5% | 1 | 942-203-03 | Allen Bradley | | |
| R10 | 22 ohm 1/4W 5% | 8 | 942-202-20 | Allen Bradley | | |
| R11 | 100K Pot | | 960-011-18 | Bourns | 3386C-1-104 | |
| R12 | 1 MEG 1/4W 5% | 3 | 942-201-05 | Allen Bradley | | |
| R13 | 1K ohm 1% | 1 | 920-410-01 | IRC | RN60C | |
| R14 | 115K ohm 1% | 1 | 920-411-53 | IRC | RN60C | |
| R15 | 220K 1/4W 5% | 2 | 942-202-24 | Sprague | | |
| R16 | 1 MEG ohm 1% | 4 | 920-410-04 | IRC | RN60C | |
| R17 | 237K ohm 1% | 1 | 920-423-73 | IRC | RN60C | |
| R18 | 56.2K ohm 1% | 1 | 920-456-22 | IRC | RN60C | |
| R19 | 1 MEG ohm 1% | | 920-410-04 | IRC | RN60C | |
| R20 | 1 MEG 1/4W 5% | | 942-201-05 | Allen Bradley | | |
| R21 | 10K Pot | 1 | 960-011-16 | Bourns | 3386C-1-101 | 1 |
| R22 | 22K 1/4W 5% | | 942-202-23 | Allen Bradley | | |

**MAIN BOARD, ASSEMBLY 400-4110** Continued

| REF DES | DESCRIPTION | QTY | DORIC P/N | MFR | MFR'S P/N | REC SPARES |
|---|---|---|---|---|---|---|
| R26, R27 | 1 MEG ohm 1% | | 920-410-04 | IRC | RN60C | |
| R28 | 100K Pot | | 960-011-18 | Bourns | 3386C-1-104 | |
| R29 | 15 MEG 1/4W 5% | 1 | 942-201-56 | Allen Bradley | | |
| R30 | 220K 1/4W 5% | | 942-202-24 | Sprague | | |
| R31 | 2.2 MEG | 1 | 942-202-25 | Sprague | | |
| R32 | 100K 1/4W 5% | 2 | 942-201-04 | Allen Bradley | | |
| R33 | 100 ohm 1/4W 5% | 1 | 942-201-01 | Allen Bradley | | |
| R34 | 1K 1/4W 5% | 3 | 942-201-02 | Allen Bradley | | |
| R35 | 100K 1/4W 5% | | 942-201-04 | Allen Bradley | | |
| R36, R37 | 10 ohm 1/4W 5% | 2 | 942-201-00 | Allen Bradley | | |
| R38, R39 | 2.2K 1/4W 5% | 2 | 942-202-22 | Allen Bradley | | |
| R40 | 10K 1/4W 5% | | 942-201-03 | Allen Bradley | | |
| R41 | 1K 1/4W 5% | | 942-201-02 | Allen Bradley | | |
| R42 | 39K 1/4W 5% | 5 | 942-203-93 | Sprague | | |
| R43 | 1K ohm 1/4W 5% | | 942-201-02 | Allen Bradley | | |
| R44, R45 | 4.7 ohm 1/4W 5% | 2 | 942-204-79 | Sprague | | |
| R46, R47 | 10K ohm 1% | 2 | 920-410-02 | IRC | RN60C | |
| R48 | 3.65K 1% | 1 | 920-436-41 | Allen Bradley | RN60C | |
| R49 | 82.5 ohm 1% | 1 | 920-382-59 | IRC | RN60D | |
| R50 | 500 ohm Pot Cermet | 1 | 960-015-01 | Beckman | 89PR | 1 |
| R51 | 4.64K 1% | 1 | 920-446-41 | IRC | RN60C | |
| R52 | 2K Pot | | 960-012-08 | Bourns | 3386C-1-202 | |
| R53-R59 | 22 ohm 1/4W 5% | | 942-202-20 | Allen Bradley | | |
| R60-R63 | 39K 1/4W 5% | | 942-203-93 | Sprague | | |
| R64 | 100K Pot Cermet | 1 | 960-011-09 | Beckman | 89PR | 1 |
| R65 | 4.7 MEG 1/4W 5% | 1 | 942-204-75 | Sprague | | |
| R68 | 3.3 MEG 1/4W 5% | 1 | 942-203-35 | Allen Bradley | | |
| S1 | Switch, Slide | 1 | 969-010-69 | Stackpole | | |
| T1 | Power Transformer | 1 | 400-7020-00 | Magnetic Dev. | | 1 |
| TB1 | Terminal Block | 1 | 973-010-32 | Reed Dev. | 6PCR-02-002 | |
| TB2 | Terminal Block | 1 | 973-010-33 | Reed Dev. | 6PCR-03-002 | |
| Z1 | CMOS | 2 | 965-587-06 | RCA | CD4066A | 1 |
| Z2 | Op. Amp. – 8 Pin | 2 | 965-590-01 | National | LM308 | 1 |
| Z3 | CMOS | | 965-587-06 | RCA | CD4066A | |
| Z4 | Op. Amp. – 8 Pin | | 965-590-01 | National | LM308 | |
| Z5, Z6 | Op. Amp. – 8 Pin | 2 | 965-592-01 | National | LM301 | 1 |
| Z7 | CMOS, CD4069AE-74C04 | 1 | 965-587-05 | RCA | | 1 |
| Z8 | Quad. Oper. Amp. | 1 | 965-599-00 | National | LM324 | 1 |
| Z9 | Custom IC | 1 | 000-750-00 | Doric | Special | 1 |

**MULTIFUNCTION BOARD, ASSEMBLY 400-4150**

| REF DES | DESCRIPTION | QTY | DORIC P/N | MFR | MFR'S P/N | REC SPARES |
|---|---|---|---|---|---|---|
| CR2-CR4, CR6-CR8, CR10-CR12, CR14, CR16 | Diode, 1N914 | 11 | 961-091-40 | Teledyne | 1N914 | |
| R1 | 20K .05% WW | 1 | 934-212-03 | Jordan | J115 | |
| R2 | 200 ohm Pot | 3 | 960-012-04 | Bourns | 3386C-1-201 | |

MULTIFUNCTION BOARD, ASSEMBLY 400-4150 Continued

| REF DES | DESCRIPTION | QTY | DORIC P/N | MFR | MFR'S P/N | REC SPARES |
|---|---|---|---|---|---|---|
| R3 | 25.834K .01% WW | 1 | 934-202-06 | Jordan | J115 | |
| R4 | 200 ohm Pot | | 960-012-04 | Bourns | 3386C-1-201 | |
| R5 | 25.696K .01% WW | 1 | 934-202-05 | Jordan | J115 | |
| R6 | 200 ohm Pot | | 960-012-04 | Bourns | 3386C-1-201 | |
| R7 | 181.972 .01% WW | 1 | 934-202-02 | Jordan | J115 | |
| R8 | 2K Pot | 3 | 960-012-08 | Bourns | 3386C-1-202 | |
| R9 | 180.637K .01% WW | 1 | 934-202-01 | Jordan | J115 | |
| R10 | 2K Pot | | 960-012-08 | Bourns | 3386C-1-202 | |
| R11 | 187.165K .01% WW | 1 | 934-202-03 | Jordan | J115 | |
| R12 | 2K Pot | | 960-012-08 | Bourns | 3386C-1-202 | |
| S1-S6 | Switch, 6 Position, 4 Pole | 1 | 969-010-21 | Centralab | PB15 | |
| S7 | Switch, Slide | 1 | 969-010-93 | Stackpole | SS-50 | 1 |

MAIN BOARD (0.1° RESOLUTION), ASSEMBLY 400-4120

| REF DES | DESCRIPTION | QTY | DORIC P/N | MFR | MFR'S P/N | REC SPARES |
|---|---|---|---|---|---|---|
| C1-C3 | 2.2MFD 35V Tantalum | 3 | 916-200-04 | Sprague | 196D | |
| C5 | .02 MFD Disc Cap 500V | 5 | 900-082-02 | Sprague | 5GASS20 | |
| C6 | 5 MFD 100V 5% Polycarbonate | 1 | 911-035-05 | IMB | DA2A | |
| C7 | 100 PF Disc Cap 1000V | 1 | 901-011-01 | Sprague | 5GAT10 | |
| C8 | .02 MFD Disc Cap 500V | | 900-082-02 | Sprague | 5GASS20 | |
| C9 | .22MFD 100V Polycarbonate | 1 | 911-032-24 | IMB | BA2B224 | |
| C10, C11 | 5 PF Duramica Cap | 3 | 915-030-50 | Sprague | DM15 | |
| C12-C14 | .005 MFD Disc Cap 1000V | 3 | 900-085-03 | Sprague | 5GAD50 | |
| C15-C17 | 390 MFD 15V Electrolytic | 3 | 910-390-15 | Sprague | 672D | |
| C18 | .01 MFD Disc Cap 500V | 1 | 900-021-04 | Sprague | 5GASS10 | |
| C19, C20 | 10 MFD 35V Tantalum | 2 | 916-010-35 | Sprague | 196D | |
| C21 | 47 PF Duramica Cap | 1 | 915-034-70 | Sprague | | |
| C23 | 6.8 MFD 35V | 1 | 916-680-04 | Sprague | | |
| C24,C25 | .02 MFD Disc Cap | | 900-082-02 | Sprague | 5GASS20 | |
| C26 | 5 PF Duramica | | 915-030-50 | Sprague | DM15 | |
| CR1-CR6 | Rectifier, 200V | 6 | 966-002-00 | Diodes, Inc. | SD-2 | 2 |
| CR7-CR12 | Diode, 1N914 | 5 | 961-091-40 | Teledyne | IN914 | |
| DS1-DS5 | .63 LED Display | 5 | 968-081-00 | Litronix | DL-750 | 1 |
| Q1, Q2 | FET, Low Leak | 5 | 100-722-02 | Teledyne | U1742C | 1 |
| Q3 | Transistor, 2N 3393 Graded | 1 | 220-720-01 | Doric | Special | 1 |
| Q4-Q6 | FET, Low Leak | | 100-722-02 | Teledyne | U1742C | |
| Q7 | Power Transistor | 1 | 964-040-00 | RCA | 40347 | 1 |
| Q8 | Power Transistor | 1 | 964-040-02 | RCA | 40406 | 1 |

MAIN BOARD (0.1° RESOLUTION), ASSEMBLY 400-4120 Continued

| REF DES | DESCRIPTION | QTY | DORIC P/N | MFR | MFR'S P/N | REC SPARES |
|---|---|---|---|---|---|---|
| Q9-Q20 | Darlington Transistor, TO-92 | 12 | 964-040-03 | Motorola | MPSA13NPN | 3 |
| R1 | 100 MEG 1/4W 10% | 3 | 943-201-07 | Sprague | | |
| R2 | 10K 2W 5% | 1 | 942-501-03 | Sprague | | |
| R3 | 7.5K ohm 1% | 1 | 920-475-01 | IRC | RN60C | |
| R4 | 100K Pot | 4 | 960-011-18 | Bourns | 3386C-1-104 | 1 |
| R5, R6 | 10K 1/4W 5% | 3 | 942-201-03 | Allen Bradley | | |
| R7 | 100K Pot | | 960-011-18 | Bourns | 3386C-1-104 | |
| R8 | 4.7K 1/4W 5% | 2 | 942-204-75 | Sprague | | |
| R9 | 30K 1/4W 5% | 1 | 942-203-03 | Allen Bradley | | |
| R10 | 22 ohm 1/4W 5% | 8 | 942-202-20 | Allen Bradley | | |
| R11 | 100K Pot | | 960-011-18 | Bourns | 3386C-1-104 | |
| R12 | 10 MEG 1/4W 5% | 1 | 942-201-06 | Sprague | | |
| R13 | 1K .05% WW | 1 | 934-211-74 | Jordan | J115 | |
| R14 | 47.5K 1% | 1 | 920-447-52 | IRC | RN60C | |
| R15 | 220K 1/4W 5% | 2 | 942-202-24 | Sprague | | |
| R16 | 449K 1% | 1 | 920-449-93 | IRC | RN60C | |
| R18 | 22.5K .05% WW | 1 | 934-212-09 | Jordan | | |
| R19 | 400K .05% WW | 1 | 934-211-84 | Jordan | | |
| R20 | 390K 1/4W 5% | 1 | 942-203-94 | Allen Bradley | | |
| R21 | 10K Pot | 2 | 960-011-16 | Bourns | 3386C-1-101 | 1 |
| R22 | 22K 1/4W 5% | 1 | 942-202-23 | Allen Bradley | | |
| R23 | 2K Pot | 2 | 960-012-08 | Bourns | 3386C-1-202 | 1 |
| R24, R25 | 100 MEG 1/4W 10% | | 943-201-07 | Sprague | | |
| R27 | 845K 1% | 1 | 920-484-53 | IRC | RN60C | |
| R28 | 10K Pot | | 960-011-16 | Bourns | 3386C-1-101 | |
| R29 | 15 MEG 1/4W 5% | 1 | 942-201-56 | Allen Bradley | | |
| R30 | 220K 1/4W 5% | | 942-202-24 | Sprague | | |
| R31 | 2.2 MEG | 1 | 942-202-25 | Sprague | | |
| R32 | 1 MEG 1/4W 5% | 1 | 942-201-05 | Sprague | | |
| R33 | 1K 1/4W 5% | 3 | 942-201-02 | Allen Bradley | | |
| R35 | 100K 1/4W 5% | 1 | 942-201-04 | Allen Bradley | | |
| R36, R37 | 10 ohm 1/4W 5% | 2 | 942-201-00 | Allen Bradley | | |
| R38, R39 | 2.2K 1/4W 5% | 2 | 942-202-22 | Allen Bradley | | |
| R40 | 10K 1/4W 5% | | 942-201-03 | Allen Bradley | | |
| R41 | 1K 1/4W 5% | 2 | 942-201-02 | Allen Bradley | | |
| R42 | 39K 1/4W 5% | 6 | 942-203-93 | Sprague | | |
| R43 | 1K ohm 1/4W 5% | | 942-201-02 | Allen Bradley | | |
| R44, R45 | 4.7 ohm 1/4W 5% | 2 | 942-204-79 | Sprague | | |
| R46, R47 | 10K .05% WW | 2 | 934-211-75 | Jordan | | |
| R48 | 3.65K 1% | 1 | 920-436-41 | Allen Bradley | RN60C | |
| R49 | 500 ohm Pot Cermet | 1 | 960-015-07 | Beckman | 3386C-1-501 | 1 |
| R50 | 500 ohm Pot Cermet | 1 | 960-015-01 | Beckman | 89PR | 1 |

MAIN BOARD (0.1° RESOLUTION), ASSEMBLY 400-4120 Continued

| REF DES | DESCRIPTION | QTY | DORIC P/N | MFR | MFR'S P/N | REC SPARES |
|---|---|---|---|---|---|---|
| R51 | 20K ohm 1% | 1 | 920-420-02 | IRC | RN60C | |
| R52 | 2K Pot | | 960-012-08 | Bourns | 3386C-1-202 | |
| R53–R59 | 22 ohm 1/4W 5% | | 942-202-20 | Allen Bradley | | |
| R60-R63 | 39K 1/4W 5% | | 942-203-93 | Sprague | | |
| R64 | 100K Pot Cermet | 1 | 960-011-09 | Beckman | 89PR | 1 |
| R65 | 4.7 MEG 1/4W 5% | | 942-204-75 | Sprague | | |
| R66 | 39K 1/4W 5% | | 942-203-93 | Sprague | | |
| R67 | 100 ohm 1/4W 5% | 1 | 942-301-01 | Allen Bradley | | |
| R68 | 3.3 MEG 1/4W 5% | 1 | 942-203-35 | Allen Bradley | | |
| S1 | Switch, Slide | 1 | 969-010-69 | Stackpole | | 1 |
| T1 | Power Transformer | 1 | 400-7020-00 | Magnetic Dev. | | 1 |
| TB1 | Terminal Block | 1 | 973-010-32 | Reed Dev. | 6PCR-02-002 | |
| TB2 | Terminal Block | 1 | 973-010-33 | Reed Dev. | 6PCR-03-002 | |
| Z1 | CMOS | 2 | 965-587-06 | RCA | CD4066A | 1 |
| Z2 | Op. Amp. – 8 Pin | 1 | 965-604-00 | National | | 1 |
| Z3 | CMOS | | 965-587-06 | RCA | CD4066A | |
| Z4 | Op. Amp. – 8 Pin | 1 | 965-590-01 | National | LM308 | 1 |
| Z5 | Op. Amp. | 1 | 965-603-00 | National | LM318N | 1 |
| Z6 | Op. Amp. – 8 Pin | 2 | 965-592-01 | National | LM301 | 1 |
| Z7 | CMOS, CS4069AE-74C04 | 1 | 965-587-05 | RCA | | 1 |
| Z8 | Quad. Oper. Amp. | 1 | 965-599-00 | National | LM324 | 1 |
| Z9 | Custom IC | 1 | 000-750-00 | Doric | Special | 1 |

DISPLAY BLANKING BOARD, ASSEMBLY 400-4160

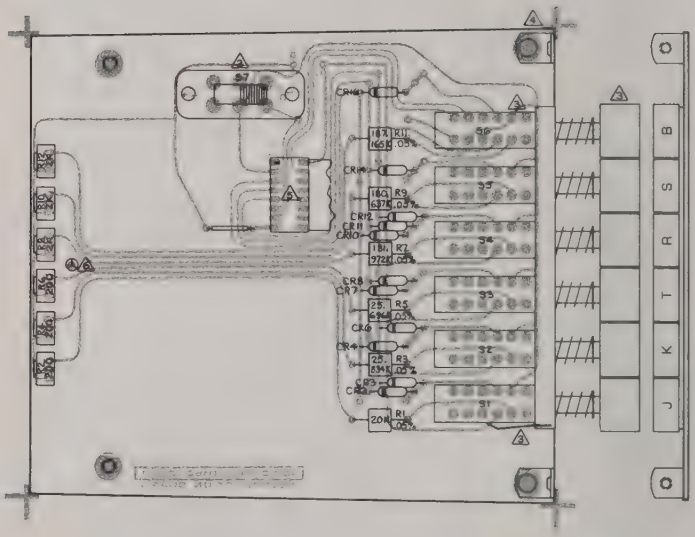
| REF DES | DESCRIPTION | QTY | DORIC P/N | MFR | MFR'S P/N | REC SPARES |
|---|---|---|---|---|---|---|
| | FET Low Leak | 1 | 100-722-02 | Teledyne | U1742C | |
| | .02 MFD Dics Cap 500V | 1 | 900-082-02 | Sprague | 5GASS20 | |
| | 47 PF Duramica Cap | 1 | 915-034-70 | Sprague | | |
| | 100 ohm 1/4W 5% | 2 | 942-201-01 | Allen Bradley | | |
| | 6.8K 1/4W 5% | 3 | 942-206-82 | Allen Bradley | | |
| | Op. Amp – 8 Pin | 1 | 965-592-01 | National | 301A | |
| | Terminal Block | 1 | 973-010-32 | Reed | 6PCR-02-002 | |
| | IC Socket, 16 Pin | 1 | 992-010-05 | Augat | | |

MISCELLANEOUS SPARE PARTS

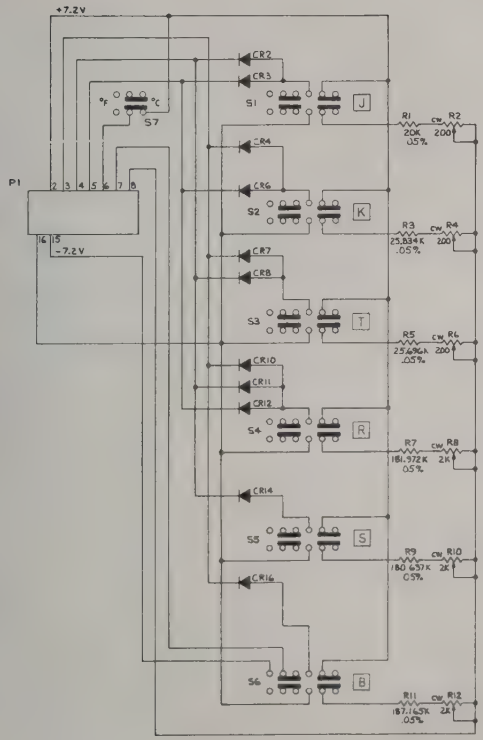
| | | | | |
|---|---|---|---|---|
| Nameplate, Front Panel | | 400-206X-00 | Doric | Specify range, °C or °F, and number of pushbuttons |
| Gasket "O" Ring, | 1 | 400-2230-00 | Doric | |
| Rear Panel | 1 | 400-2040-00 | Doric | |
| Front Panel, Plexiglas | 1 | 400-2030-02 | Doric | |

# SECTION 6

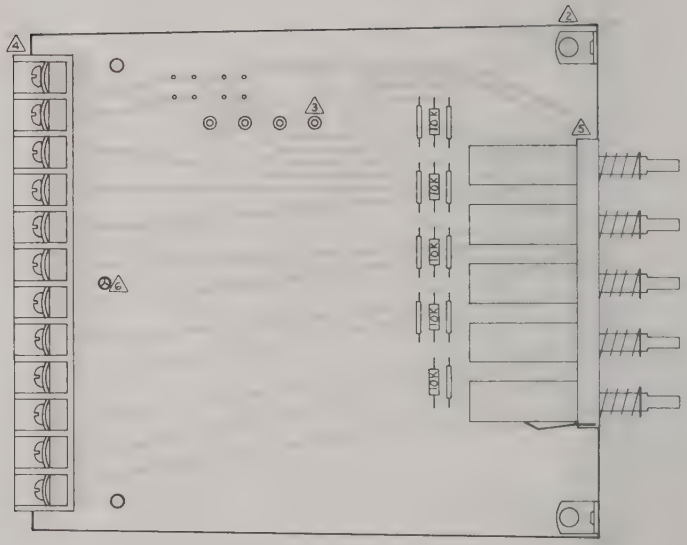
# SCHEMATICS



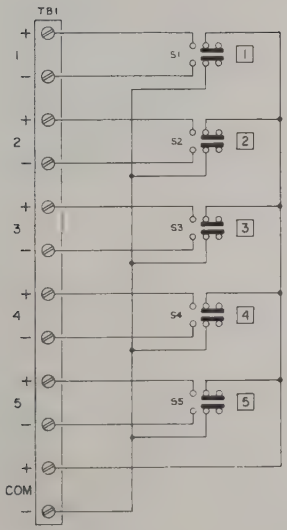

MULTIFUNCTION BOARD
ASSEMBLY 400-4150-00



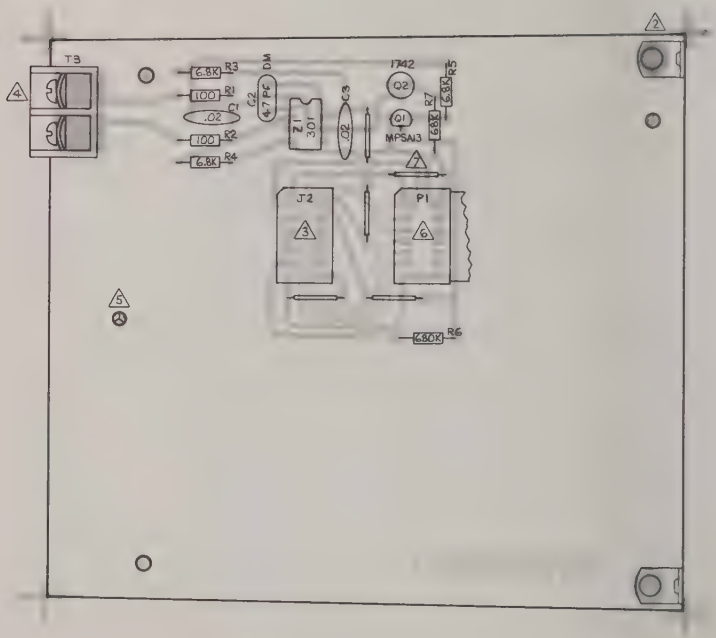

*MULTIFUNCTION BOARD SCHEMATIC 400-6150-00*



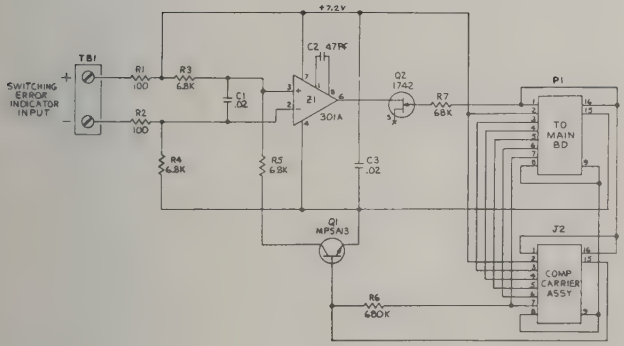

SWITCH BOARD
ASSEMBLY 400-4141-00



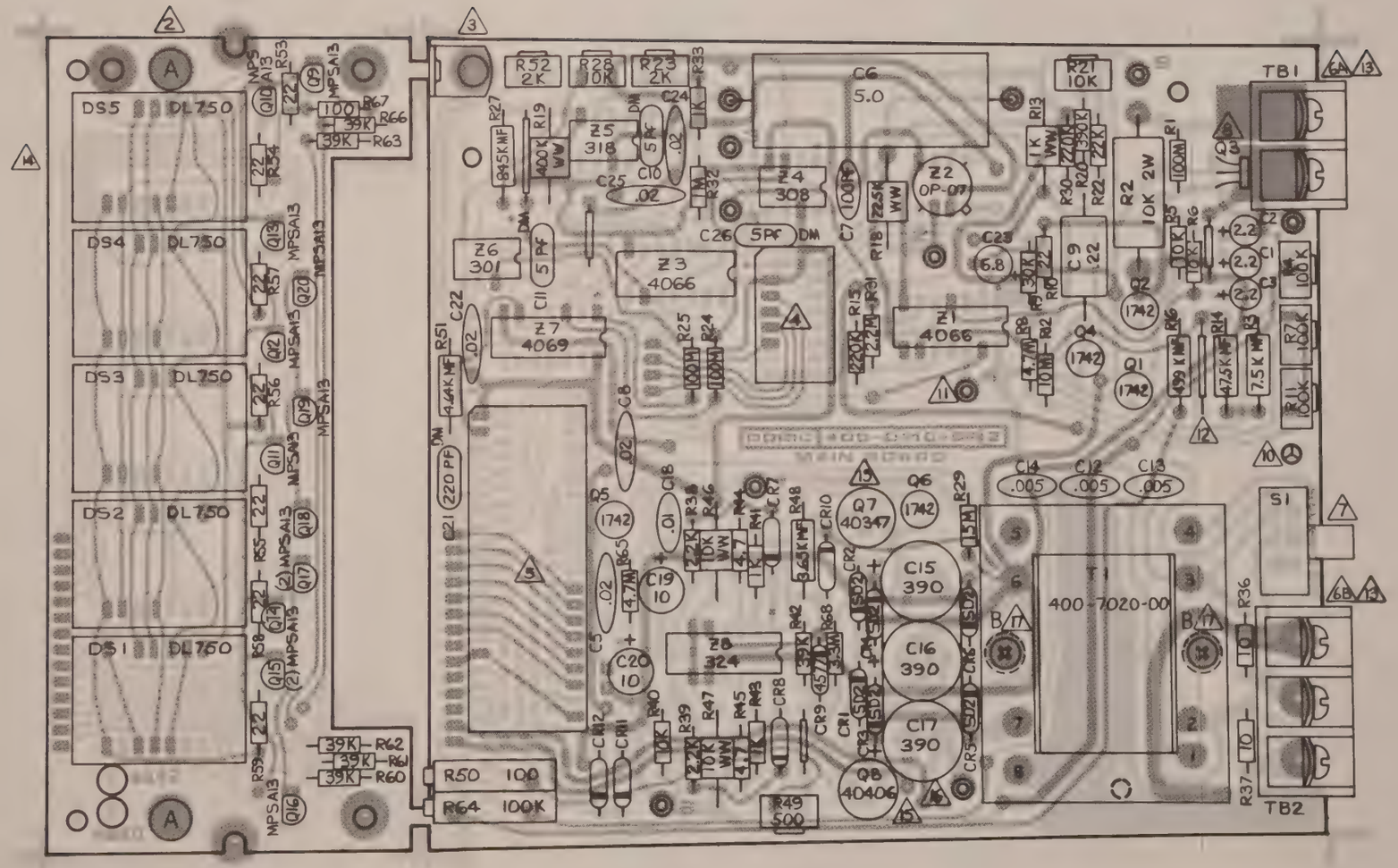

*SWITCH BOARD*
*SCHEMATIC 400-6140-00*



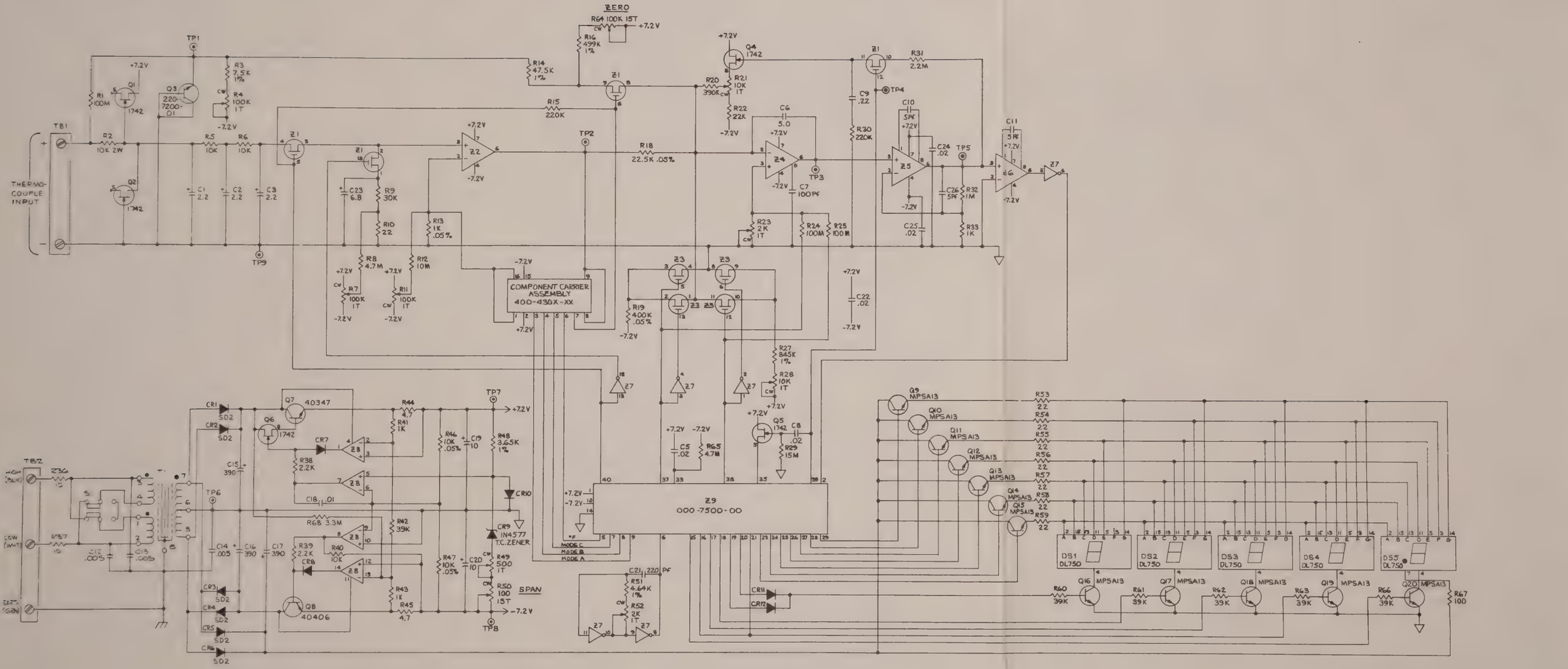

*SWITCHING ERROR INDICATOR ASSEMBLY 400-4160-01*



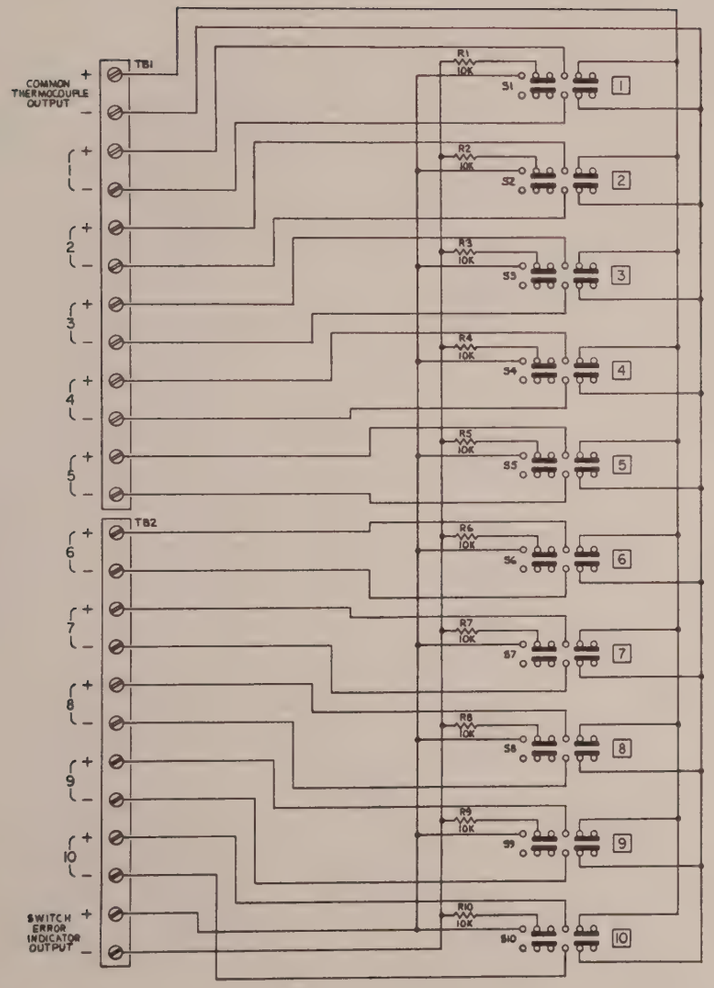

*SWITCHING ERROR INDICATOR SCHEMATIC 400-6160-01*




*MAIN BOARD*
*0.1° RESOLUTION*
*ASSEMBLY 400-4120-02*



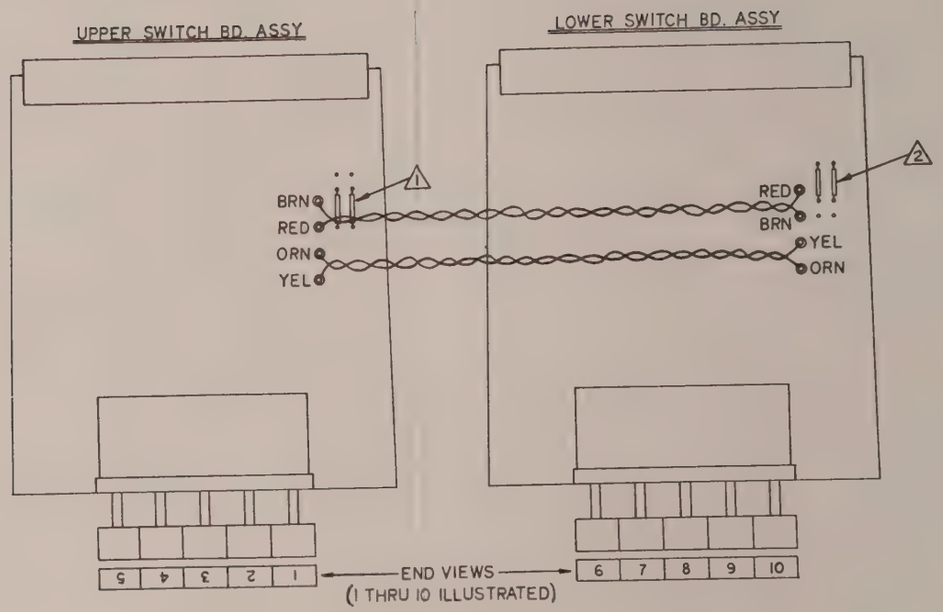

MAIN BOARD
0.1° RESOLUTION
SCHEMATIC 400-6120-02




NOTES:

1. BOXED NUMBERS INDICATE THERMOCOUPLE INPUT NUMBER. (1 THRU 10 ILLUSTRATED)
2. SWITCHES S1 THRU S5 AND S6 THRU S10 ARE INTERLOCKING TYPE.

*EXTERNAL SWITCHING UNIT (MODEL 405) SCHEMATIC 400-6380-00*

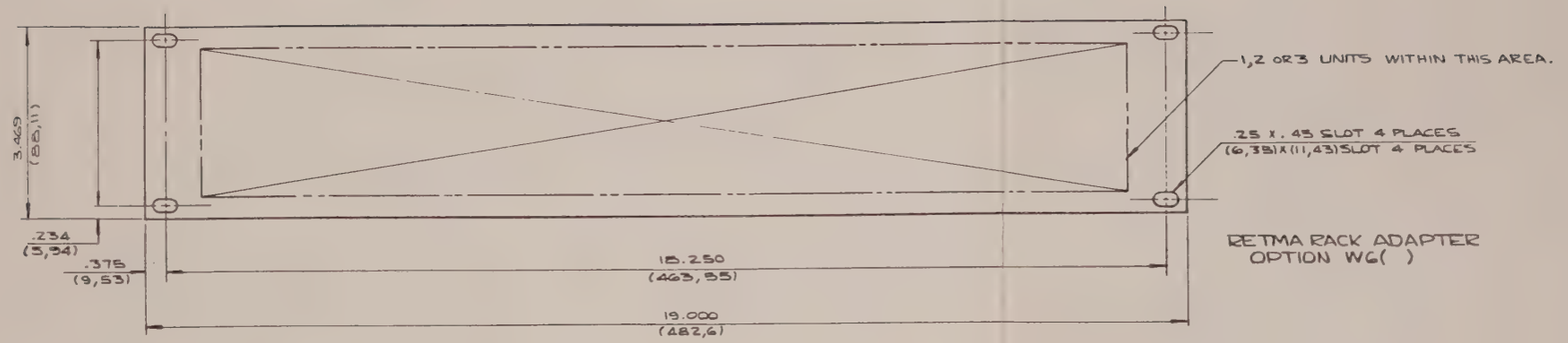


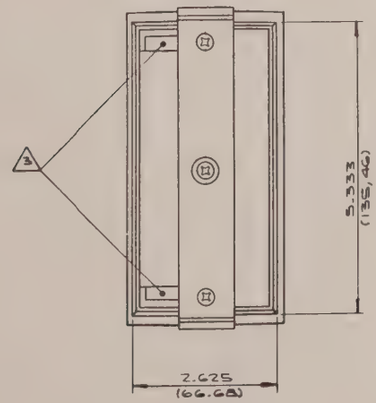

⚠2 JUMPERS ON LOWER BD. MUST BE IN REARWARD SET OF HOLES.

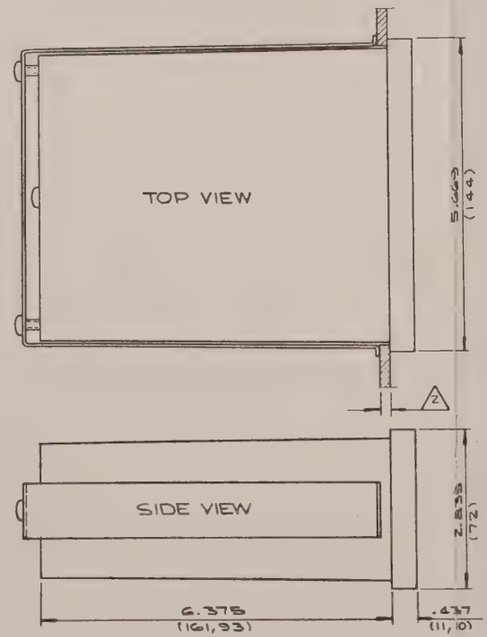
⚠1 JUMPERS ON UPPER BD. MUST BE IN FORWARD SET OF HOLES.

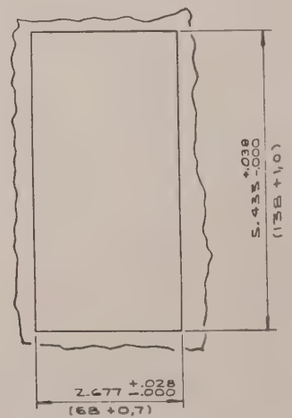
NOTES:

*EXTERNAL SWITCHING UNIT (MODEL 405) ASSEMBLY 400-4380-00*



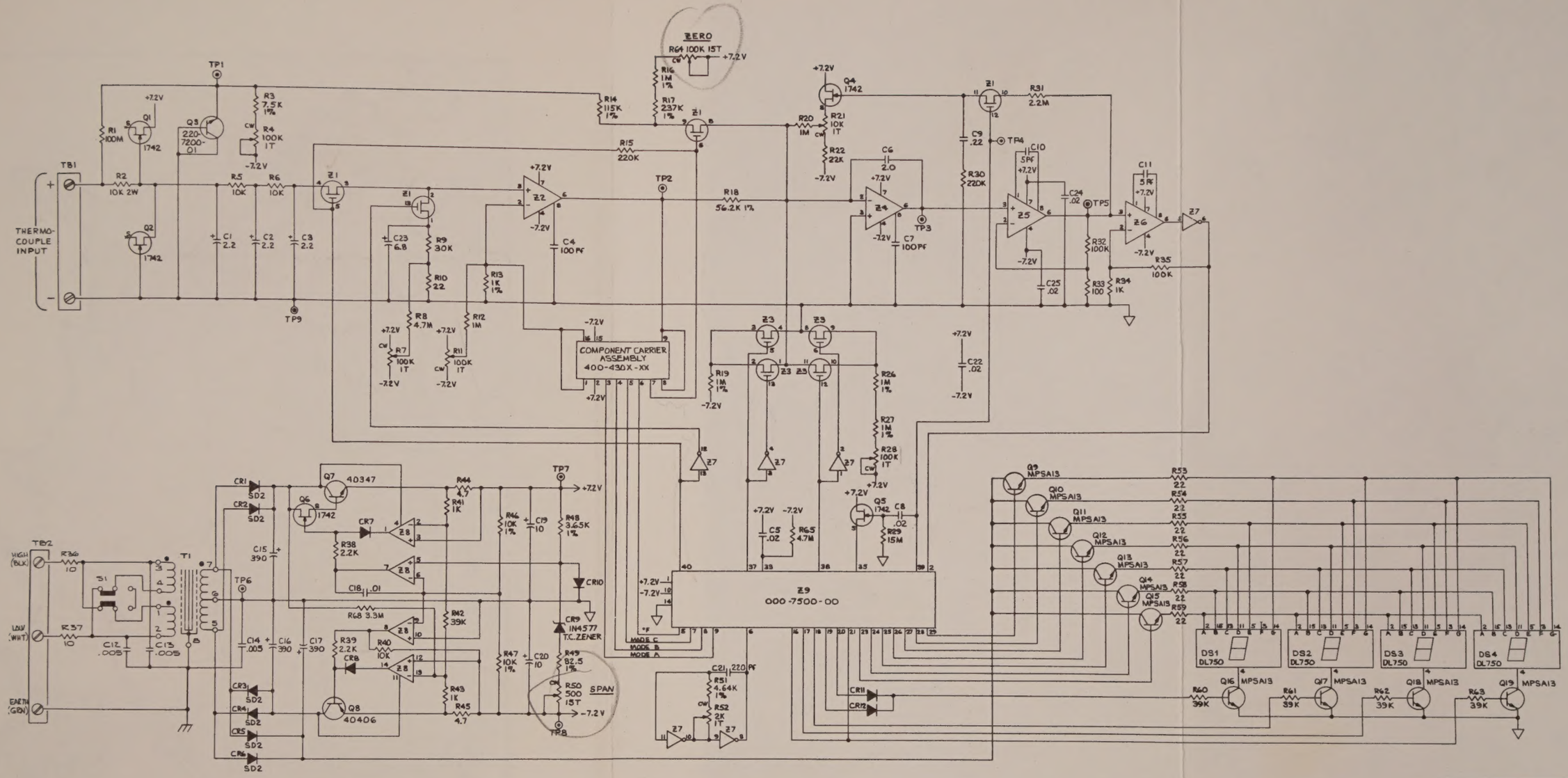



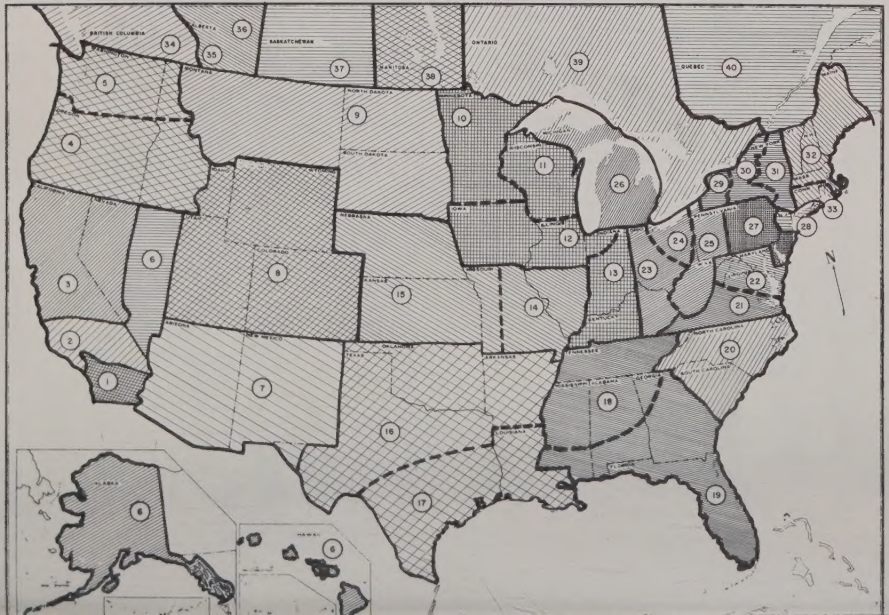

4 CUTOUT CONFORMS TO A144X77 DIN 43700.
3 WIRING ENTRANCE.
2 CUSTOMER PANEL .38(9,6) MAXIMUM.
1. DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)
NOTES:

*DIMENSIONAL OUTLINE DRAWING 000-7407-00*

*MAIN BOARD (1°)*
*ASSEMBLY 400-4110-02*




*MAIN BOARD (1°)*
*SCHEMATIC 400-6110-02*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TEXAS
NEW MEXICO
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COLORADO
WYOMING
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IDAHO
UTAH
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OREGON
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TENNESSEE
MISSISSIPPI
ALABAMA
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